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The Radioactive Waste Management at Studsvik

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ABSTRACT

The report was originally prepared as a contribution to the discussions in an IAEA panel on economics of radioactive waste management held in Vienna from 13 - 17 December 1965. It contains the answers and comments to the questions of a questionnaire for the panel concerning the various operations associated with the management (collection, transport, treatment, discharge, storage, and operational monitoring) of:

- radioactive liquid wastes, except high-level effluents from reactor fuel recovering operations;
- solid wastes, except those produced from treatment of high-level wastes;
- gaseous wastes produced from treatment of the foregoing liquid and solid wastes;
- equipment decontamination facilities and radioactive laundries.

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1. INFORMATION ABOUT THE MAJOR WASTE-
PRODUCING OPERATIONS AT THE SITE

1.1 The major sources of radioactive wastes

Most of the radioactive wastes originate from the following sources:

- a) - a 30 MW research reactor (R2) with 5 loops
- b) - three Zero-energy reactors (R2-0, R0 and FR-0)
- c) - isotope production (about 2000 Ci/year)
- d) - High Active Laboratory (fuel element inspection, materials research etc)
- e) - Central Hot Laboratory (development of plutonium enriched fuel, general chemical and physical research)
- f) - heavy water purification plant
- g) - ion exchange resin treatment plant.

1.2 The personnel distribution

The personnel distribution among the areas of activity listed in sub. 1.1 are estimated below. The figures include all personnel who ordinarily work in classified areas. They may or may not be direct producers of active wastes.

a)	75	persons
b)	45	"
c)	12	"
d)	80	"
e)	25	"
f) and g)	<u>8</u>	"
	245	"
Miscellaneous	<u>50</u>	"
	295	"

About 300 persons are normally working in radioactive surroundings. The member of benchworkers, in its literal sense, are estimated to about 150.

In total 800 persons are working at Studsvik.

2. INFORMATION ABOUT THE WASTES AND THEIR MANAGEMENT

2.1 Types and amounts of wastes

2.1.1 Liquid wastes

The guiding principle at the design of the liquid collection systems has been to invest rather heavily in drain pipes and tanks in order to minimize the operating cost. The wastes are segregated into several categories defined at the origin, table 1 [1].

The main contents of the various categories are shown in table 2. The figures refer to the 1965 production.

2.1.2 Solid wastes

Solid wastes are segregated into three main categories

- low level solid wastes, less than 1 mCi per bin
- high level solid wastes, more than 1 mCi per bin
- solid wastes containing high toxic materials.

Each of these categories are subdivided into

- combustible materials
- noncombustible materials
- special materials (pyroforic materials, organic wastes, sludge etc.)

Table 3 shows the amounts of solid wastes during 1965.

[1] LINDHE S and LINDER P,
The Handling of Liquid Waste at the Research Station of Studsvik,
Sweden.1965. (AE-182)

Table 1. Segregation of the liquid waste into categories

Category	Source	Collection	Transport	Treatment	Spec. activity	
					Max. Ci/m ³	Average Ci/m ³
1. High active waste	Boxes, cells	Shielded flasks, truck		Storage		1 x 10 ²
2. "Reactor incident water"	Reactor R2	Dealy tanks,	pipe in duct	Evaporation		
3. Medium active	Boxes, cell, re-actor loops, fume cupboards sinks	Delay tanks,	pipe in duct	Evaporation	1	3 x 10 ⁻²
4. Low active waste	Fume cupboards, open benches, sinks	---	pipe in duct	Control tanks	1 x 10 ⁻²	1 x 10 ⁻⁴
5. Process water	Cooling water etc. from active processes	---	pipe in duct	Control tanks	1 x 10 ⁻⁶	0
5R. Reactor cooling water	R2 secondary cooling circuit	---	pipe in duct	Monitor control valve ¹⁾		
6. Sewage water	Toilets, lavatories	---	pipe in ground	Cleaning plant control tanks	1 x 10 ⁻⁶	0
7. Surface water from active areas	Gutters etc. Cooling water from inactive processes	---	pipe in ground	Control valve ¹⁾	1 x 10 ⁻⁶	0
8. Surface water from inactive areas	Do.	---	pipe in ground	Control point		

1) for diverting to control tanks when so required

Table 2. Volumes and Contents of liquid wastes during 1965

Category	Volume m ³	Total α mCi	Total β mCi	Nuclides	Chemicals
1	0.155	199000		F.P., Pu, U, various isotopes	Sulph. acids, nitric acids, solvents
2	0	0	0	-	Demineralized water
3	578	8	46300	F.P., Pu, U, various isotopes	Various acids and alkalies
4	16135	28	1345	F.P., Pu, U, various isotopes	Various acids and alkalies
5	32785	10	79	-	Fresh and saline water
5R	10.5 · 10 ⁶	0	0	-	Fresh and saline water
6	214932	7	34	-	Sewage

Table 3. Amount and activities of solid wastes during 1965

Category	Number of items	Volume m ³	Activity Ci
combustible	1979	85	2
Low level non-combustible	672	20	1
special	40	1	1
combustible	36	1	65
High level non-combustible	135	3	6340
special	11	0.2	130
combustible	362	16	1
High toxic non-combustible	83	5	1
special	6	0.3	0.2

2.2 Collection at the sources

2.2.1 Liquid wastes

Table 1 indicates the principles of collection of various categories of liquid wastes.

The activities and content of cat. 1 are always determined at the source. The data are based on the figures furnished by the producers but are authenticated by record keeping and monitoring.

Cat. 2 and 3 are monitored by sampling in the delay tanks before further treatment.

Cat. 4, 5 and 6 are monitored by automatic sampling at the control tanks before discharge into the Baltic.

Cat. 5R is monitored by automatic detector and manual sampling three times a day. These samples are analyzed three times a week.

Cat. 7 and 8 are normally disposed without control.

2.2.2 Solid wastes

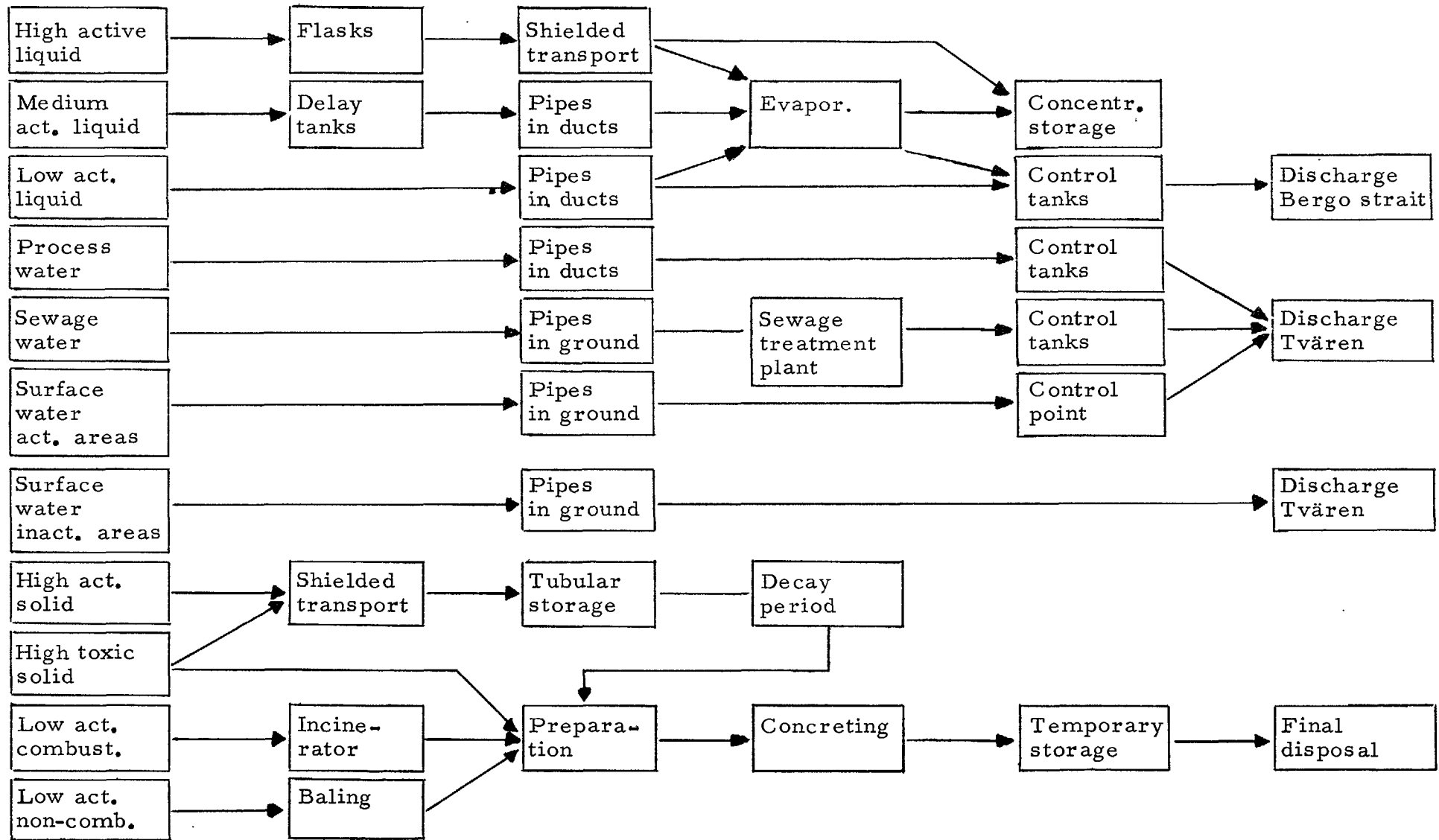
Low active combustible and non-combustible wastes are collected in separate bins at the source. The wastes are monitored by the health physics personnel before transport to the waste treatment plant.

High active, toxic and special materials are collected in special containers, designed in accordance with the nature of the wastes. The activity and nuclides are determined after the same principles as for high active liquid wastes (cat. 1).

2.3 Waste treatment flowsheet

Fig. 1 illustrates the principles for collection, transport, treatment and disposal of both liquid and solid wastes.

Fig. 1. Waste treatment flow sheet



2.4 Distribution of waste management personnel

The approximate distribution of the personnel on the various operations of waste management is shown in table 4.

Table 4. Distribution of personnel (man-years)

	<u>Liquid</u>	<u>Solid</u>	<u>Gas.</u>	<u>Total</u>
- general direction and support				1.5
- collection and monitoring prior to transport	1.0	0.4		1.4
- transport	0.8	1.3		2.1
- sorting		0.3		0.3
- waste treatment and discharge	1.0	1.4	0.4	2.8
- conditioning of the concentrates and storage or disposal	0.2			0.2
- monitoring and analysis asso- ciated with treatment and dis- charge	4.6	0.5		5.1
- environmental monitoring	2.5		1.5	4.0
- maintenance	0.4	0.1	2.5	3.0
- equipment decontamination and laundry operations		1.7		1.7
Total	10.5	5.7	4.4	22.1

2.5 Operational consumption

The important consumptions (chemicals, power etc.) required by the operation of the different systems are listed below

- collection and monitoring prior to transport:

bins, drums, polythene bottles, plastic bags, sealing tape, lables

- transport:

petrol, oil, tires, ropes, cover materials

- sorting:

drums, gloves, compressed air, power

- waste treatment and discharge:

chemicals, steam, power, compressed air, water, sand, cement, reinforcing bars, drums

- conditioning of the concentrates and storage or disposal:
absorbents, chemicals, drums, power, compressed air
- monitoring and analysis associated with treatment and discharge:
chemicals, glass-ware, planchettes, bottles for samples, power, water, pressure air, calor gas
- maintenance:
power, compressed air, welding materials, tools, spare parts, oil, grease, pipes, tubes
- equipment decontamination and laundry operations:
degreasers, descaling agents, detergents, washing powder, acids, alkalies, brushes, cloth, emery paper, steel wool, plastic sheets and bags, tools, power, compressed air, steam, water
- general consumptions:
garments, shoes, gloves, plastic suits.

2.6 Costs of general services

The costs of general services pertaining to waste management are not charged to the waste management operations. Such services are radiation protection, medical control, environmental control and a few services of little importance on the maintenance side.

2.7 Research and development

Under the present organization, where the waste management section is an operational unit no research and development work of importance is carried out. The present routines and methods are in the main established and only improvements and development on installations and processes are necessary.

3. INFORMATION ABOUT THE ACCOUNTANCY SYSTEM

3.1 The principles of the accountancy system

The accountancy system is not wholly based on operations like these listed in Table 4. Instead it comprises three main classes viz. liquid, solid and gaseous wastes. In addition there are separate ac -

counts for "overheads", disposal control, decontamination, laundry and "maintenance" accounts for different buildings.

3.2 Cost calculations

3.2.1 Operational costs

The operational costs are calculated in yearly budgets subdivided into accounts listed in sub. 3.3. The cost figures are based upon operational experience from previous years with consideration taken to known and anticipated changes. All waste management operations like collection, treatment, discharge and monitoring for disposal are included in the budget.

The accounts for 1965 show that the separate costs for this year were lying within ± 10 % of the calculated figures.

3.2.2 Investment costs

Investments in new buildings and equipment are not included in the operational costs but are calculated and accounted separately.

3.3 Description of the accountancy system

The budget for the waste management contains the following accounts:

- "overheads"
- common operations
- solid wastes - low active
- " - high active
- liquid wastes - disposal control
- " - treatment (incl. collection and transport)
- decontamination - central
- decontamination on site
- laundry operations
- active ventilation
- maintenance of Disposal Laboratory
- " " Storage Building
- " " Solid Waste Treatment Plant
- " " Liquid Waste Treatment Plant
- " " Decontamination Centre

All operational costs are charged on the various accounts. Salaries are debited from weekly time lists kept by each man including supervisors. In addition direct materials and services from units outside the waste management section are charged. The figures of the various accounts are computed each month and reported to the section.

3.4 and 3.5 "Overheads"

The account for "overheads" mentioned in sub. 3.3 only covers administrative expenses such as those parts of salaries which can not be charged to other accounts, travelling expenses, stationary etc. The charges to the "overheads" account are kept to an absolute minimum and even the salary of the section head is distributed among the operational accounts as far as possible. The salary of the local secretary is always charged to the "overheads" account.

In addition there are "overheads" not covered by the budget of the waste management section. These involve supervision above section head, health physics, medical control, guards, maintenance of buildings, power and heat, general services such as library, fire brigade, vehicle services, local inactive transports, central administration etc.

3.6, 3.7 and 3.8 Depreciation and capital cost

Depreciation and capital costs are not charged the waste management accounts, but are accounted centrally. The depreciation time for buildings such as decontamination centre and liquid waste treatment plant are usually 10 years. Drainage systems including tanks and equipment are written off immediately after completion. Capital costs are not taken into consideration in the waste management budget.

The section also gives services to outside establishments. The fee for such services include both depreciation and capital costs.

Depreciation of the whole waste system among the different operation accounts has not been made since there has been no use for such distribution of depreciation costs. However, the necessary figures are available and the distribution among the accounts of the present budget would be fairly simple. If a distribution of the depreciation cost on operations like those listed in sub. 2.4 were asked for the work would be most difficult to accomplish.

3.9 Amortization of research and
development costs

All costs for research and development required to develop the treatment and other work operations are charged on special accounts, but are immediately written off. The same applies to the cost of the surveys that has been carried out to establish permissible limits of radioactive disposal and reception capacity of the environment.

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